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Personality Traits and Memory: A Multilevel Analysis Across 27 Countries From the Survey of Health, Ageing and Retirement in Europe

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Abstract

Personality traits are associated with memory in older adulthood: Individuals higher in conscientiousness and openness and lower in neuroticism tend to perform better on memory-recall tasks. We conducted a preregistered study to replicate these associations in a large, multinational cohort and test whether the associations varied by national-level socioeconomic indicators (e.g., per capita gross domestic product). Multilevel modeling was used to analyze data from 71,566 individuals (age: M = 67.9 years, SD = 9.5; 57% women) across 26 European countries and Israel. Higher conscientiousness, openness, and extraversion and lower neuroticism were associated with better memory performance, even when analyses accounted for risk factors including diabetes, hypertension, obesity, emotional disorders, and sleeping problems. Consistent with the resource-substitution hypothesis, results showed that higher conscientiousness and agreeableness and lower neuroticism were associated with better memory in countries with lower gross domestic product. This pattern suggests that psychological (trait) resources may help compensate for country-specific disadvantaged contexts.

Keywords

five-factor model of personality, Big Five, cross-national panel, gross domestic product, memory, older adults, open materials, preregistered

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There is consistent evidence that links the five-factor model of personality traits, or Big Five, to cognitive health in older adulthood, including memory performance (Curtis et al., 2015; Luchetti et al., 2016). Higher neuroticism tends to be associated with worse performance on memory-recall tasks (Aiken-Morgan et al., 2012; Allen et al., 2019; Klaming et al., 2017; Luchetti et al., 2016; Sutin, Stephan, Luchetti, & Terracciano, 2019), whereas higher conscientiousness and openness are related to better memory (Allen et al., 2019; Chapman et al., 2017; Graham & Lachman, 2012; Luchetti et al., 2016; Sutin, Stephan, Luchetti, & Terracciano, 2019). The associations between memory and both extraversion and agreeableness have been less consistent across studies (Allen et al., 2019; Sutin, Stephan, Luchetti, & Terracciano, 2019).

The association between personality and memory is usually examined without consideration of the broader sociocultural environment. This environment, however, may be critical for both memory function and the expression of the traits. For example, there is some evidence that the economic health of a nation, as indexed by its gross domestic product (GDP), is associated with

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cognitive function at the individual level (Wen & Gu, 2011; Wu et al., 2015). Mirowsky and Ross (2003) proposed the *resource-substitution hypothesis*, which states that one resource (e.g., education) becomes more relevant for health at lower levels of other critical resources (e.g., living in a poor family and social context; see also Ross & Mirowsky, 2011). Although formulated with reference to education and health, the resource-substitution hypothesis has also been applied to personality traits (Damian et al., 2015; Shanahan et al., 2014). That is, certain traits may function as an "inner resource" for health. For example, the attentiveness to health, diet, and exercise that is an expression of conscientiousness may help to compensate for limited access to health care and other socioeconomic inequalities (Shanahan et al., 2014). Likewise, traits such as neuroticism may exacerbate risk for negative outcomes associated with lower education and socioeconomic disadvantage (Chapman et al., 2009; Elliot et al., 2017).

To date, there is some evidence in support of these hypotheses (Elliot et al., 2017; Jaconelli et al., 2013; Sutin et al., 2011). For example, higher conscientiousness has been related to fewer health problems among individuals with lower socioeconomic status, whereas higher neuroticism has been associated with increased problems (Elliot et al., 2017). In the context of cognitive health, Sutin and colleagues (2011) found that education moderated the association between conscientiousness and performance on a verbal-fluency task; participants with lower education performed better if they were conscientious (see also Sutin, Stephan, Damian, et al., 2019). This moderation pattern could extend to memory tasks (although evidence is mixed; see Luchetti et al., 2016; Sutin, Stephan, Luchetti, & Terracciano, 2019). Note, however, that the previous studies focused exclusively on the interplay between personality and individual-level factors such as education and/or income without considering how country-level factors may contribute to the relation between personality and memory.

The present work used a large multinational cohort of individuals over the age of 50 to test the hypothesis that country-level economic indicators (e.g., GDP) moderate the relation between personality and memory performance. We hypothesized that personality traits, particularly conscientiousness and neuroticism, would be more strongly associated with memory performance in countries with fewer economic resources. More specifically, we hypothesized that higher conscientiousness would be more protective and higher neuroticism would be a greater risk factor for individuals living in countries with lower GDP. We also examined whether the moderation extends to individual-level markers of socioeconomic status (education, income).

Statement of Relevance

Around the globe, maintaining memory and other cognitive functions is a major concern for aging. There are large differences in how much individuals can remember, and such differences have been related to psychological and economic factors. In this research, we expanded prior work on personality and memory by considering the interplay between personality and the broader sociocultural context on memory function. We used a large sample that included people from many countries and found that individuals who were more conscientious and agreeable and more emotionally stable performed better on a memory task, especially when they lived in lower-income countries. These results support the idea that personality is a psychological resource that may help compensate for other important contextual resources that are missing. Moreover, the results underscore the importance of placing individuals in context to help identify who is more at risk of poor memory function and plan interventions.

Method

Participants

The current study is a preregistered analysis of data from the Survey of Health, Ageing and Retirement in Europe (SHARE), a multidisciplinary and cross-national panel of individuals age 50 years and older and their spouses (Börsch-Supan et al., 2013). We analyzed data on personality and memory from Wave 7 (2017) because personality was measured for the first time in this last wave of SHARE (Börsch-Supan, 2020; SHARE, 2020). Wave 7 also includes the largest number of SHARE participants and countries compared with previous waves.[1] The analytic sample in this study included a total of 71,566 respondents from 27 countries: Austria, Belgium, Bulgaria, Cyprus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Switzerland. Participants were included in the analyses if they had data on all personality traits and immediate- and delayed-recall memory tasks and reported age (≥ 50 years), sex, and education.

More information on the assessment, sampling, and how to obtain SHARE data can be found at http://www.share-project.org.

Measures

Individual-level measures.

Personality traits. The 10-item Big Five Inventory (BFI-10) was used to measure neuroticism, extraversion, openness, agreeableness, and conscientiousness (Rammstedt & John, 2007). The response for each item (e.g., "I see myself as someone who gets nervous easily" for neuroticism) was made on a scale from 1 (*disagree strongly*) to 5 (*agree strongly*), and the score was reversed for five of the items. For each trait, the mean was taken across the two item scales. This measure of personality is particularly suitable for multidisciplinary surveys in which assessment time is limited, and it has acceptable reliability estimates (test-retest correlations ≥ .65 across scales, as reported by Rammstedt & John, 2007; median internal consistency in the current sample = .36). Note that internal consistency underestimates the reliability for scales such as the BFI-10, in which the items are intended to measure distinct aspects of the traits, and that there is strong convergence with the longer measures of personality (Rammstedt & John, 2007).

Memory performance. Respondents were read a list of 10 common words and asked to immediately recall these words. After a short delay in which other survey questions were answered, participants were asked again to recall the 10 words (Mehrbrodt et al., 2019). Memory performance was the total number of words recalled across the immediate- and delayed-recall task (range = 0–20); more words remembered indicated better memory function.

Covariates. Mean-centered age, age squared, sex (0 = male, 1 = female), and education (from 0, preprimary level of education, to 6, second stage of tertiary education) were used as sociodemographic covariates. SHARE uses the 1997 International Standard Classification of Education to categorize and harmonize education statistics across countries (United Nations Educational, Scientific and Cultural Organization, 2003). SHARE does not collect information on race/ethnicity. Additional covariates were clinical factors known to impact late-life cognition (Baumgart et al., 2015): diabetes (yes/no), high blood pressure or hypertension (yes/no), affective or emotional disorders and/or use of drugs for anxiety/depression (yes/no), the use of drugs for sleep problems (yes/no), and obesity (body mass index ≥ 30). Clinical factors were coded as 1 (presence/yes) or 0 (absence/no). Sensitivity analyses excluded participants who reported a diagnosis of Alzheimer's disease, dementia, or senility (yes/no). Additional exploratory analyses used imputed data on monthly household income provided by SHARE. These analyses were originally not preregistered because income data were imputed for 40% (n = 29,259) of the analytic sample (for more information on imputation methodology, see SHARE, 2020, pp. 46–50).

Country-level measures. We considered GDP per capita as a country-level socioeconomic indicator possibly related to cognitive health and health disparities. GDP is a measure of economic activity in relation to the size of the population. This measure is expressed in thousands of current U.S. dollars. Countries with higher GDP are assumed to have a higher per capita income. In addition to considering GDP, we considered two other country-level indicators, the Gini index and health expenditure. The Gini index is a measure of income inequality. It measures the extent to which the distribution of income among individuals or households within a country deviates from an equal distribution. Values are expressed as a percentage, from 0 (*perfect equality*) to 100 (*perfect inequality*). Health expenditure per country is healthcare goods and services consumed each year, expressed as a percentage of country GDP. For all indices, we retrieved information from The World Bank data from 2017 or the closest year prior to the SHARE interview (https://databank.worldbank.org/source/world-development-indicators). In the current sample, GDP per capita ranged from 8.2 (Bulgaria) to 104.5 (Luxembourg). The Gini index ranged from 25.4% (Slovenia) to 38.9% (Israel). Health expenditure (percentage of GDP) ranged from 5.0% (Romania) to 12.2% (Switzerland).

Data analysis

The preregistration of the analysis plan can be found at https://osf.io/vy3fg. A multilevel approach was used to account for the nested nature of the data. That is, 71,566 individuals (Level 1) were nested within 27 countries (Level 2). We first fitted a null random-intercept-only model (without predictors) and calculated the intraclass correlation (ICC) to determine the proportion of variance in memory scores explained by the country-level clustering. We then fitted a series of models separately for each personality trait. Model 1 examined individual-level personality (e.g., neuroticism) as a predictor of memory performance, controlling for covariates (age centered, age squared, sex, and education). Model 2 added GDP as a country-level predictor. Model 3 included a cross-level interaction between personality and GDP. In Model 4, we tested the robustness of the personality associations with memory by adding the clinical risk factors to Model 1 as covariates

(i.e., diabetes, hypertension, emotional disorders, sleep problems, and obesity). In all models, the slope between personality and memory was allowed to vary across countries; the random-effects covariance matrix was set to unstructured form. This specification (which was not preregistered) was guided by the observed variability in memory scores explained by the country clustering so that the effect of personality on memory was allowed to vary from country to country. We also ran a series of sensitivity and exploratory analyses. First, we retested Model 1 after excluding participants who reported a diagnosis of Alzheimer's disease, dementia, or senility. Second, we explored whether the personality associations with memory varied on the basis of participants' age, sex, education, and income and whether there were interactions between traits (e.g., Neuroticism × Conscientiousness; see Turiano et al., 2020). Lastly, we tested interactions between personality and the alternative country-level predictors (Gini index and health expenditure). All analyses were conducted using SPSS software (Version 25), and the plots were created using the *sjPlot* package (Version 2.8.4; Lüdecke, 2020) in the R software environment (Version 4.0.2; R Core Team, 2020). Significance was set to $p < .01$.

Results

Descriptive statistics for the total sample and for each country are reported in Table 1. The null model (without predictors) indicated significant variability in memory scores within ($\sigma^2_{within} = 12.58$, Wald $z = 189.13$, $p < .001$) and between ($\sigma^2_{between} = 1.02$, Wald $z = 3.65$, $p < .001$) countries. The ICC, $\sigma^2_{between}/(\sigma^2_{between} + \sigma^2_{within})$, was .08, which indicated that 8% of the total variance in memory was attributable to country-specific differences.

Main analyses

Models predicting memory scores from personality are displayed in Table 2. As expected, higher neuroticism was associated with lower memory scores in analyses controlling for age, age squared, sex, and education (Model 1). In contrast, higher extraversion, openness, and conscientiousness were associated with higher memory scores (all ps $< .01$). This pattern of associations was generally consistent across countries (for statistics of each country, see Table S1 in the Supplemental Material available online). The association between agreeableness and memory tended toward significance ($p = .014$). Model 1 explained 24% of individual-level variance in memory; standardized effects (βs) of personality traits were in the range of 0.03 to 0.08, and each personality trait accounted for about 1% of the interindividual variance compared with when only demographic covariates were entered in the model.

Country-level GDP contributed to participants' performance on the memory task, accounting for 8% to 47% of variation in memory scores among countries (Model 2): In countries with higher GDP, participants had higher memory scores. Notably, there was a significant cross-level interaction between neuroticism and GDP (Model 3) and a trend for agreeableness and GDP ($p = .013$) and conscientiousness and GDP ($p = .017$). As shown in Figure 1a, neuroticism was associated with worse memory in countries in the bottom quartile of GDP (< \$20,000; $n = 20{,}533$; $\beta = -0.12$, 95% confidence interval [CI] = [−0.17, −0.08], $p < .001$) compared with countries in the top quartile of GDP (> \$45,000; $n = 14{,}293$; $\beta = -0.04$ (95% CI = [−0.07, −0.01], $p = .013$). For conscientiousness, the positive association with memory was apparent only in countries with lower per capita income (see Fig. 1b)—$\beta = 0.09$, 95% CI = [0.04, 0.15], $p = .003$ for countries in the bottom GDP quartile; $\beta = 0.01$, 95% CI = [−0.02, 0.03], $p = .515$ for countries in the top GDP quartile. The same pattern was found for agreeableness (see Fig. 1c)—$\beta = 0.05$, 95% CI = [0.01, 0.10], $p = .032$ for countries in the bottom GDP quartile; $\beta = -0.01$, 95% CI = [−0.03, 0.01], $p = .222$ for countries in the top GDP quartile.

Note that all observed associations between personality and memory remained significant when analyses accounted for clinical risk factors that affect cognition (Model 4), specifically diabetes, hypertension, emotional disorders, sleep problems, and obesity (see Table S2 in the Supplemental Material). Further, the associations held when participants with a diagnosis of Alzheimer's disease, dementia, or senility ($n = 990$) were excluded from the analyses (see Table S3 in the Supplemental Material).

We then examined alternative country-specific socioeconomic indices. Lower income inequality (i.e., lower Gini index) and higher levels of health expenditure per country were associated with better memory performance. However, there were no significant interactions between personality and these country-level socioeconomic indicators (see Tables S4 and S5 in the Supplemental Material). The only exception was an interaction between extraversion and health expenditure ($\beta = -0.02$, 95% CI = [−0.04, −0.00], $p = .010$): The association between extraversion and memory was stronger in countries with lower health expenditure. This latter interaction was not hypothesized a priori and is likely due to chance.

Additional (interaction) analyses

Only a few associations between personality traits and memory were qualified by individual-level factors, such as age and sex (see Fig. S1 in the Supplemental Material).

Table 1. Characteristics of the Sample

	Individual-level measures									Country-level measures			Dependent measure: memory	
					Personality trait									
Country	Sample size (*n*)	Age (mean years)	Female (%)	Education (mean years)	N	E	O	A	C	GDP	Gini	Health expenditure	*M* (*SD*)	*SE*
Austria	2,937	70.2 (9.1)	60.0	3.3 (1.3)	2.4 (1.0)	3.6 (1.0)	3.5 (1.1)	3.6 (0.8)	4.2 (0.8)	47.4	30.5	10.4	10.1 (3.7)	0.07
Belgium	4,623	67.4 (9.9)	55.5	3.2 (1.5)	2.8 (1.0)	3.5 (0.9)	3.3 (1.0)	3.6 (0.8)	4.2 (0.7)	43.5	27.7	10.0	9.8 (3.6)	0.05
Bulgaria	1,899	66.3 (9.5)	57.0	2.9 (1.2)	2.6 (0.9)	3.7 (0.9)	3.4 (0.7)	3.5 (0.9)	4.3 (0.8)	8.2	37.4	8.2	7.9 (3.1)	0.07
Croatia	2,309	65.9 (8.9)	55.4	2.8 (1.2)	2.8 (0.8)	3.8 (0.8)	2.9 (0.9)	3.6 (0.7)	4.2 (0.7)	13.4	31.1	7.2	8.4 (3.5)	0.07
Cyprus	1,133	68.7 (10.2)	58.3	2.2 (1.6)	3.0 (1.3)	3.0 (0.7)	3.4 (0.9)	3.1 (1.0)	4.6 (0.7)	25.8	34.0	6.9	7.4 (3.6)	0.11
Czech Republic	3,882	69.5 (8.3)	60.2	2.8 (1.1)	2.8 (0.9)	3.3 (0.8)	3.3 (0.9)	3.5 (0.8)	3.9 (0.8)	20.4	25.9	7.1	9.5 (3.3)	0.05
Denmark	3,112	66.4 (9.4)	54.0	3.7 (1.3)	2.0 (1.0)	4.0 (1.1)	3.0 (1.1)	4.2 (0.8)	4.3 (0.8)	57.2	28.2	10.4	10.3 (3.5)	0.06
Estonia	4,554	69.2 (9.9)	64.0	3.4 (1.2)	2.5 (1.1)	3.7 (1.0)	3.7 (0.9)	3.6 (0.8)	3.9 (0.9)	20.2	32.7	6.7	9.0 (3.8)	0.05
Finland	1,864	65.7 (9.5)	54.2	3.3 (1.6)	2.3 (1.0)	3.5 (1.0)	3.6 (1.0)	4.0 (0.8)	3.9 (0.9)	45.8	27.1	9.5	9.5 (3.5)	0.08
France	3,114	68.7 (9.9)	57.9	2.8 (1.7)	2.9 (1.0)	3.3 (0.8)	3.3 (0.9)	3.7 (0.8)	4.3 (0.7)	38.7	32.7	11.5	9.4 (3.6)	0.06
Germany	3,641	67.3 (9.1)	52.6	3.6 (1.1)	2.6 (1.0)	3.4 (1.0)	3.5 (1.0)	3.5 (0.8)	4.2 (0.8)	44.7	31.7	11.1	10.2 (3.5)	0.06
Greece	2,934	69.1 (9.2)	57.0	2.4 (1.6)	3.5 (0.9)	3.1 (0.7)	3.0 (0.8)	3.5 (0.7)	4.0 (0.7)	18.9	36.0	8.5	8.4 (3.2)	0.06
Hungary	1,451	68.5 (7.9)	61.1	3.1 (1.0)	2.6 (1.0)	3.1 (0.7)	3.1 (0.9)	3.3 (0.7)	4.1 (0.7)	14.3	30.4	7.4	9.1 (3.6)	0.09
Israel	1,719	69.0 (8.8)	57.4	3.3 (1.6)	2.5 (0.9)	3.5 (0.8)	3.4 (0.9)	3.6 (0.9)	4.1 (0.8)	40.5	38.9	7.3	9.1 (3.4)	0.08
Italy	4,193	68.1 (9.3)	54.6	2.1 (1.3)	2.7 (0.8)	3.2 (0.8)	3.3 (0.9)	3.7 (0.7)	4.0 (0.7)	32.2	35.4	8.9	8.0 (3.5)	0.05
Latvia	1,618	66.6 (10.2)	63.0	3.5 (1.2)	2.8 (1.0)	3.2 (1.1)	3.1 (0.6)	3.6 (0.8)	4.0 (0.8)	15.7	34.2	6.2	8.7 (3.9)	0.10
Lithuania	1,955	66.2 (10.5)	63.9	3.5 (1.3)	2.8 (1.0)	3.3 (0.7)	3.1 (1.1)	3.9 (0.9)	4.0 (0.9)	16.8	37.4	6.7	7.9 (3.5)	0.08
Luxembourg	1,094	66.0 (8.6)	55.3	2.8 (1.6)	2.6 (1.1)	3.6 (0.9)	3.5 (1.0)	3.9 (0.8)	4.3 (0.7)	104.5	33.8	6.2	10.4 (3.9)	0.11
Malta	1,223	66.6 (8.8)	55.8	2.1 (1.4)	2.7 (1.1)	3.9 (0.9)	3.1 (1.0)	3.7 (0.9)	4.6 (0.6)	27.2	29.4	9.3	8.3 (3.4)	0.10
Poland	4,369	65.3 (9.5)	55.0	2.9 (1.1)	2.8 (0.8)	3.3 (0.7)	3.2 (0.8)	3.2 (0.7)	4.0 (0.7)	13.9	31.8	6.5	8.0 (3.3)	0.05
Portugal	1,079	69.0 (8.1)	56.5	1.7 (1.4)	2.9 (1.1)	3.4 (1.0)	3.4 (0.9)	4.0 (0.8)	4.3 (0.8)	21.3	35.5	9.1	7.0 (3.3)	0.10
Romania	2,023	65.4 (9.3)	56.6	2.5 (1.1)	2.8 (1.0)	3.8 (0.9)	3.2 (0.9)	3.7 (1.0)	4.2 (0.9)	10.8	35.9	5.0	7.6 (3.7)	0.08
Slovakia	1,975	62.0 (8.0)	52.9	3.1 (0.8)	2.6 (0.9)	3.5 (0.8)	3.3 (0.6)	3.5 (0.8)	4.1 (0.8)	17.6	26.5	7.1	9.5 (4.0)	0.09
Slovenia	3,399	68.4 (9.1)	59.5	2.9 (1.2)	2.6 (0.9)	3.6 (0.9)	3.3 (0.6)	3.9 (0.6)	4.2 (0.7)	23.4	25.4	8.5	8.7 (3.6)	0.06
Spain	4,180	70.2 (9.8)	55.6	1.7 (1.5)	2.6 (1.0)	3.5 (1.0)	3.2 (1.0)	3.8 (0.8)	4.1 (0.8)	28.2	36.2	9.0	7.3 (3.4)	0.05
Sweden	2,991	71.3 (8.5)	53.8	3.2 (1.5)	2.2 (1.0)	3.7 (1.0)	3.1 (1.0)	4.1 (0.7)	4.1 (0.8)	53.3	29.2	10.9	9.6 (3.5)	0.06
Switzerland	2,295	69.5 (9.2)	54.4	3.3 (1.2)	2.5 (0.9)	3.5 (0.9)	3.6 (0.9)	3.7 (0.8)	4.2 (0.7)	80.3	32.3	12.2	10.6 (3.7)	0.08
Total	71,566	67.9 (9.5)	57.0	2.9 (1.4)	2.7 (1.0)	3.5 (0.9)	3.3 (0.9)	3.7 (0.8)	4.1 (0.8)	32.7 (22.3)	32.1 (3.8)	8.4 (1.9)	8.9 (3.7)	0.01

Note: Unless otherwise noted, all individual-level measures are means (standard deviations are in parentheses). Totals for the country-level measures are also means plus standard deviations. At the country level, the sample size ranged between 1,079 (Portugal) and 4,623 (Belgium). The personality traits are neuroticism (N), extraversion (E), openness (O), agreeableness (A), and conscientiousness (C). For the country-level measures, gross domestic product (GDP) per capita indicates per capita income (expressed in thousands of U.S. dollars), the Gini index indicates income inequality (expressed as a percentage; 0 = *perfect equality* and 100 = *perfect inequality*), and health expenditure is the percentage of GDP spent for health.

Table 2. Parameter Estimates and Variance From Multilevel Models Predicting Memory Scores From Personality and Gross Domestic Product (GDP)

	Model 1			Model 2			Model 3		Model 3 centering		
Trait and parameter	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	Estimate	*SE*	β
Neuroticism											
Intercept	7.405***	0.146		6.453***	0.206		6.892***	0.231	8.703***	0.102	
Neuroticism	−0.271***	0.038	−0.074***	−0.270***	0.038	−0.074***	−0.446***	0.056	−0.270***	0.030	−0.075***
GDP				0.029***	0.005	0.147***	0.016*	0.006	0.030***	0.005	0.152***
Neuroticism × GDP							0.005***	0.001	0.005***	0.001	0.028***
Intercept variance	0.514***	0.151		0.479**	0.158		0.393***	0.118	0.267***	0.074	
Slope (trait) variance	0.034**	0.011		0.034**	0.011		0.020**	0.007	0.020**	0.007	
Intercept and slope covariance	−0.012	0.029		−0.085*	0.037		−0.051*	0.024	0.004	0.016	
Extraversion											
Intercept	5.874***	0.231		4.904***	0.229		4.646***	0.303	8.716***	0.104	
Extraversion	0.229***	0.034	0.057***	0.228***	0.034	0.057***	0.293***	0.061	0.228***	0.033	0.057***
GDP				0.030***	0.005	0.151***	0.037***	0.008	0.031***	0.005	0.156***
Extraversion × GDP							−0.002	0.001	−0.002	0.002	−0.009
Intercept variance	1.339***	0.385		0.706***	0.216		0.670***	0.205	0.279***	0.077	
Slope (trait) variance	0.026**	0.009		0.026**	0.009		0.024**	0.008	0.024**	0.008	
Intercept and slope covariance	−0.133**	0.051		−0.107**	0.040		−0.098**	0.037	−0.014	0.018	
Openness											
Intercept	5.805***	0.208		4.844***	0.243		5.092***	0.337	8.726***	0.104	
Openness	0.315***	0.048	0.080***	0.315***	0.047	0.080***	0.240**	0.085	0.314***	0.047	0.080***
GDP				0.029***	0.005	0.149***	0.022*	0.008	0.029***	0.005	0.149***
Openness × GDP							0.002	0.002	0.002	0.002	0.011
Intercept variance	1.081***	0.312		0.872***	0.265		0.854***	0.256	0.282***	0.078	
Slope (trait) variance	0.055**	0.017		0.055**	0.017		0.053**	0.017	0.053**	0.017	
Intercept and slope covariance	−0.115*	0.062		−0.180**	0.063		−0.174**	0.060	0.000	0.025	
Agreeableness											
Intercept	6.260***	0.275		5.329***	0.256		4.696***	0.341	8.728***	0.104	
Agreeableness	0.114*	0.043	0.026*	0.114*	0.043	0.026*	0.268***	0.070	0.112**	0.038	0.026**
GDP				0.028***	0.005	0.145***	0.048***	0.009	0.030***	0.005	0.156***
Agreeableness × GDP							−0.005*	0.002	−0.005*	0.002	−0.020*
Intercept variance	1.927***	0.552		1.029***	0.318		0.848***	0.256	0.281***	0.078	
Slope (trait) variance	0.044**	0.014		0.044**	0.014		0.033**	0.011	0.033**	0.011	
Intercept and slope covariance	−0.244**	0.081		−0.182**	0.062		−0.139**	0.049	−0.016	0.021	
Conscientiousness											
Intercept	5.698***	0.316		4.710***	0.289		3.951***	0.404	8.712***	0.104	
Conscientiousness	0.233***	0.052	0.051***	0.232***	0.052	0.051***	0.412***	0.085	0.231***	0.047	0.051***
GDP				0.030***	0.005	0.154***	0.054***	0.010	0.031***	0.005	0.158***
Conscientiousness × GDP							−0.006*	0.002	−0.005*	0.002	−0.022*
Intercept variance	2.534***	0.727		1.452***	0.443		1.187***	0.360	0.280***	0.078	
Slope (trait) variance	0.065***	0.020		0.065***	0.020		0.051***	0.016	0.051***	0.016	
Intercept and slope covariance	−0.352**	0.113		−0.277**	0.089		−0.216**	0.072	−0.004	0.025	

Note: Total $N = 71{,}566$. All models control for basic covariates (age centered, age squared, sex, and education). In the Estimate columns, unstandardized coefficients are given for predictors and variance components. SPSS produces only unstandardized coefficients in multilevel modeling. To derive standardized coefficients, we reran the models by *z*-scoring all variables prior to the analyses (Snijders & Bosker, 2012). For models testing cross-level interactions, we repeated the analyses centering the predictor variables. Results were consistent with those observed using nontransformed variables.

*$p < .05$. **$p < .01$. ***$p \leq .001$.

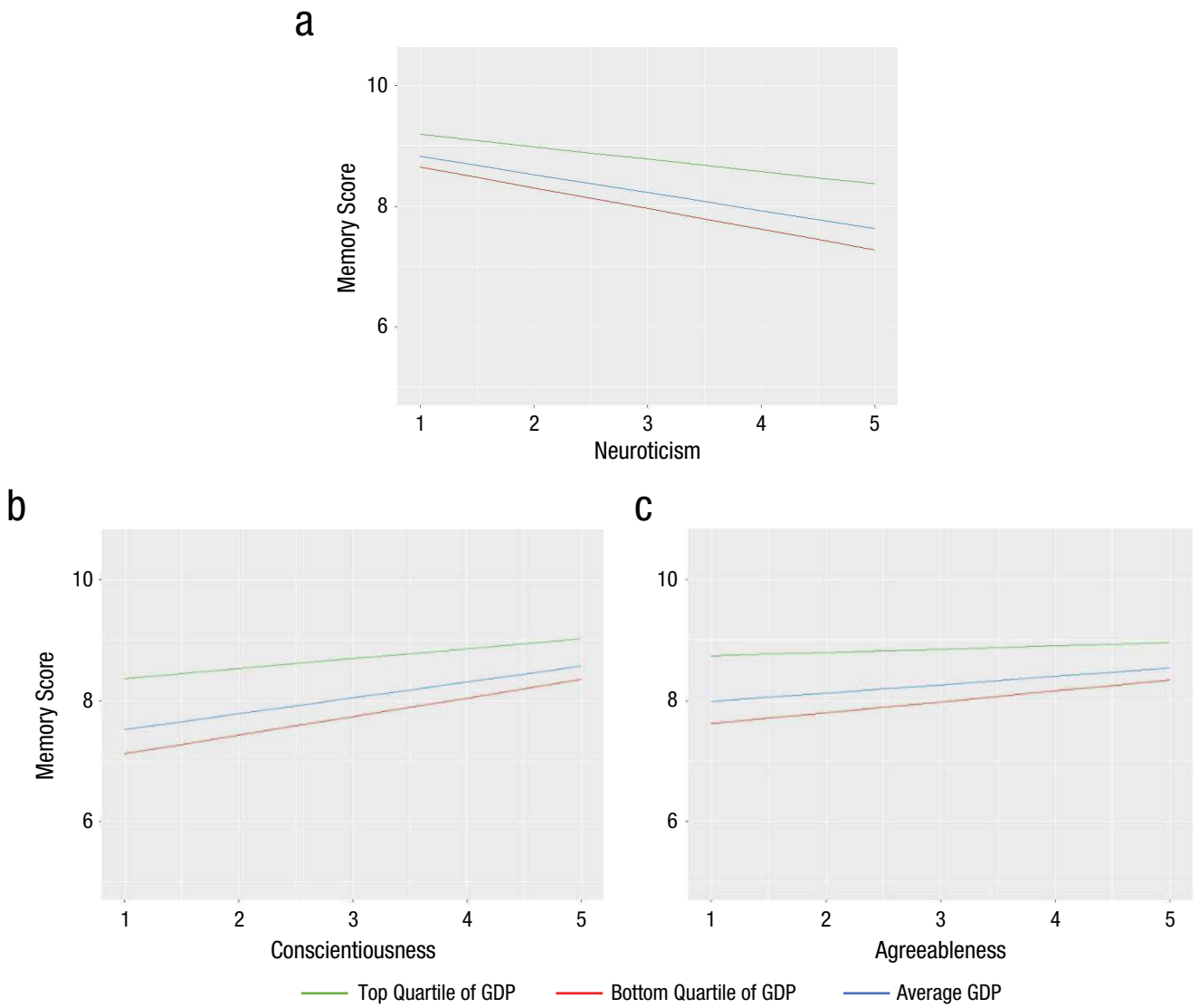

Fig. 1. Mean memory performance as a function of country-level gross domestic product (GDP) and (a) neuroticism, (b) conscientiousness, and (c) agreeableness.

Specifically, the association between neuroticism and memory (β = −0.02, 95% CI = [−0.03, −0.01], p = .003) was stronger among men than women, the association between openness and memory (β = 0.02, 95% CI = [0.01, 0.03], p = .002) was stronger among women than men, and the association between agreeableness and memory was slightly stronger at younger ages than relatively older ages (β = −0.01, 95% CI = [−0.01, −0.00], p = .006). We found an interaction between conscientiousness and income (β = −0.01, 95% CI = [−0.02, −0.00], p = .006): This trait was associated with better memory, in particular among individuals with lower income (SHARE provides five imputations of missing values; the interaction with conscientiousness was replicated regardless of which income imputation was used, even though the significance level was attenuated at p < .05 when two of the five income imputations were used). There were no significant interactions between personality and education.

In addition, there were interactions between conscientiousness and neuroticism (β = 0.01, 95% CI = [0.01, 0.02], p < .001), extraversion (β = −0.01, 95% CI = [−0.02, −0.00], p = .002), openness (β = −0.01, 95% CI = [−0.01, −0.00], p = .005), and agreeableness (β = −0.01, 95% CI = [−0.02, −0.00], p = .001) and between extraversion with openness (β = −0.01, 95% CI = [−0.01, −0.00], p = .009). These interactions suggested that the association of certain traits with memory varied on the basis of the level of other traits. For example, participants higher in conscientiousness had better memory when they

were also lower in neuroticism and higher in extraversion, openness, and agreeableness (see Fig. S2 in the Supplemental Material). We note, however, that the observed interaction effects were relatively small and need to be replicated in other samples.

Discussion

This study examined the association between personality and memory using a multilevel analysis of 27 countries. Results indicated that participants higher in conscientiousness, openness, and extraversion and lower in neuroticism performed better on the memory-recall task, even after analyses controlled for clinical risk factors that affect memory and when participants with a diagnosis of dementia were excluded. The effect sizes, although modest, were similar to what has been observed in prior studies and were similar in magnitude to many clinically established risk factors for memory impairments (see Allen et al., 2019; Luchetti et al., 2016). Most associations were similar across ages (or cohorts) examined; the effects were also similar for women and men and were generally in the same direction in each individual country. These findings support the robustness of the relation between personality and memory and the importance of examining the role of psychological traits in cognitive function in later adulthood.

Consistent with the resource-substitution hypothesis, results showed that personality traits were more relevant for memory in countries with less economic prosperity. Being more conscientious and agreeable, for example, was a psychological resource when living in less advantageous national contexts: Both traits were associated positively with memory performance in countries with lower GDP but not in countries with higher GDP. Conscientiousness and agreeableness are likely to be associated with memory performance, in part, through behaviors that help maintain cognitive function (Turiano et al., 2018), including more physical activity (Allen et al., 2019), less consumption of alcohol and cigarettes (Hakulinen, Elovainio, et al., 2015; Hakulinen, Hintsanen, et al., 2015), and more social interactions (Swickert et al., 2010). Conscientiousness is also associated with fewer depressive symptoms and more adaptive coping strategies when one faces stressful situations (Klein et al., 2011), which may help attenuate stress-related physiological responses that may impair memory over time (Sartori et al., 2012). These mechanisms might be particularly relevant when compensating for important missing resources, such as limited access to health care and other social and material resources in less economically robust countries.

Neuroticism, in contrast, was associated with poor memory. In the current study, the negative association between neuroticism and memory performance was stronger in countries with lower GDP and attenuated in countries with higher per capita income. Neuroticism has been associated with a wide range of behaviors that increase risk of negative health outcomes (Turiano et al., 2018), including inflammation and physiological dysregulations, particularly among individuals living in disadvantaged social and family contexts (as noted by Chapman et al., 2011; see also Elliot et al., 2017). Individuals who are emotionally stable (low in neuroticism), in contrast, may be less susceptible to such adversity and stress and thus better able to maintain their health and memory.

The results of this study are consistent with moderation patterns observed between personality and individual-level socioeconomic indices that affect health (e.g., education; Jaconelli et al., 2013; Sutin, Stephan, Damian, et al., 2019) and extend this body of work by identifying national-level factors that modulate personality associations with memory. There were, however, no significant interactions with other country-level socioeconomic indices (the Gini index and health expenditure) or with individual-level education and income. The exception was an interaction between conscientiousness and income; the association was stronger among individuals with lower income, consistent with the interaction with GDP. Of note, the results highlight the importance of personality traits in environments with fewer economic resources and challenge the argument that personality matters only in rich contexts (Boyce & Wood, 2011; for discussions, see Damian et al., 2015, and Shanahan et al., 2014).

This study has several strengths, especially the large sample size of middle-age and older adults from 27 countries. In addition to economic differences, these countries also differ in culture, history, and language. Thus, the sample was relatively diverse in its composition. A few limitations need to be noted. First, the study relied on a 10-item measure of personality. Although valid and useful for inclusion in large surveys, the BFI-10 may underestimate effect sizes and does not measure specific facets (or subscales) of the traits. Second, a simple word-recall task was used to assess memory function. Future work should test whether the results will replicate when different memory tasks (e.g., visual memory tasks) and other tasks assessing different domains (e.g., verbal fluency and executive function) are used. Third, the observational study design limits inferences on causality, and there may be reciprocal associations between the constructs (Wettstein et al., 2017). It is necessary to follow up with longitudinal

investigations to examine changes in personality and memory across cross-national samples.

Despite these limitations, the current study has important theoretical and practical implications. From a theoretical perspective, this study adds evidence in support of the resource-substitution hypothesis: Higher conscientiousness and agreeableness and lower neuroticism help compensate for the absence of contextual resources that affect individuals' memory function at old ages. From a practical perspective, assessing personality and its interplay with contextual factors may be useful to identify individuals most at risk for memory impairments and planning interventions. Indeed, focusing on the individual without the context in which he or she lives might limit the effectiveness of an intervention directed to maintain cognitive health. Some interventions may also be directed to change personality to achieve benefits in an identified at-risk population (Chapman et al., 2014). For example, there is evidence for psychological interventions that reduce neuroticism-related psychological processes (i.e., rumination and physical tension; see Roberts et al., 2017). This type of intervention might be particularly helpful when targeting adults living in stressful and disadvantaged contexts, who are at higher risk for poor health outcomes. Nevertheless, it may also be possible to intervene on the context in which the person lives to foster more adaptive personality traits and consequently better outcomes (Chapman et al., 2014). Indeed, some studies suggest that family and neighborhood socioeconomic status influence the development of traits during childhood and adolescence (Strickhouser & Sutin, 2020). These effects may extend to older populations as well. Additional work that translates these ideas into the public health arena is needed (Chapman et al., 2014). Even though the cross-sectional associations observed in the present study were modest in size, the combined effect of personality and context could have large public health significance because of the impact on multiple health-related domains. It could activate a causal chain of factors leading to poor memory.

In sum, this study added evidence about the associations between personality traits and memory performance observed in previous studies by examining socioeconomic contextual factors that may shape the associations. Additional work is needed to replicate the findings and test whether the results extend to other sociocultural contexts outside Europe, such as countries from Asia, Africa, or Latin America that have lower per capita income compared with European countries.

Transparency

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Author Contributions

M. Luchetti, A. Terracciano, and A. R. Sutin developed the study concept. M. Luchetti analyzed and interpreted the data in collaboration with A. Terracciano and A. R. Sutin. M. Luchetti drafted the manuscript, and all the coauthors provided critical revisions. D. Aschwanden generated the figures. All the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Open Practices

Data for this study were drawn from the Survey of Health, Ageing and Retirement in Europe and are available after registration at http://www.share-project.org/data-access/. Analytic syntax and outputs have been made publicly available via OSF and can be accessed at https://osf.io/w5zc6. The design and analysis plan for this study were preregistered on OSF and can be accessed at https://osf.io/vy3fg. Statistical details that were not specified in the preregistration are noted in the text. This article has received the badges for Open Materials and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797621993101

Note

1. The study was preregistered in December 2019. Since the preregistration, SHARE released a new version of the data (Version 7.1.0; see http://www.share-project.org/data-documentation/share-data-releases.html). In the review process, we updated our data file to reflect the latest state of data cleaning (released in June 2020); this last version also includes the complete Portuguese sample assessed in Wave 7. Note that the structure of the interview in Wave 7 was different from its structure in previous waves. In the last wave, SHARE administered SHARELIFE modules for respondents who did not participate in Wave 3 (first SHARELIFE wave) as well as the regular modules for respondents who already participated in the first SHARELIFE interview. Respondents who completed SHARELIFE also received a condensed set of questions from the regular questionnaire. Personality, memory, and the health-related data were part of this condensed set of questions and thus available for the entire sample.

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